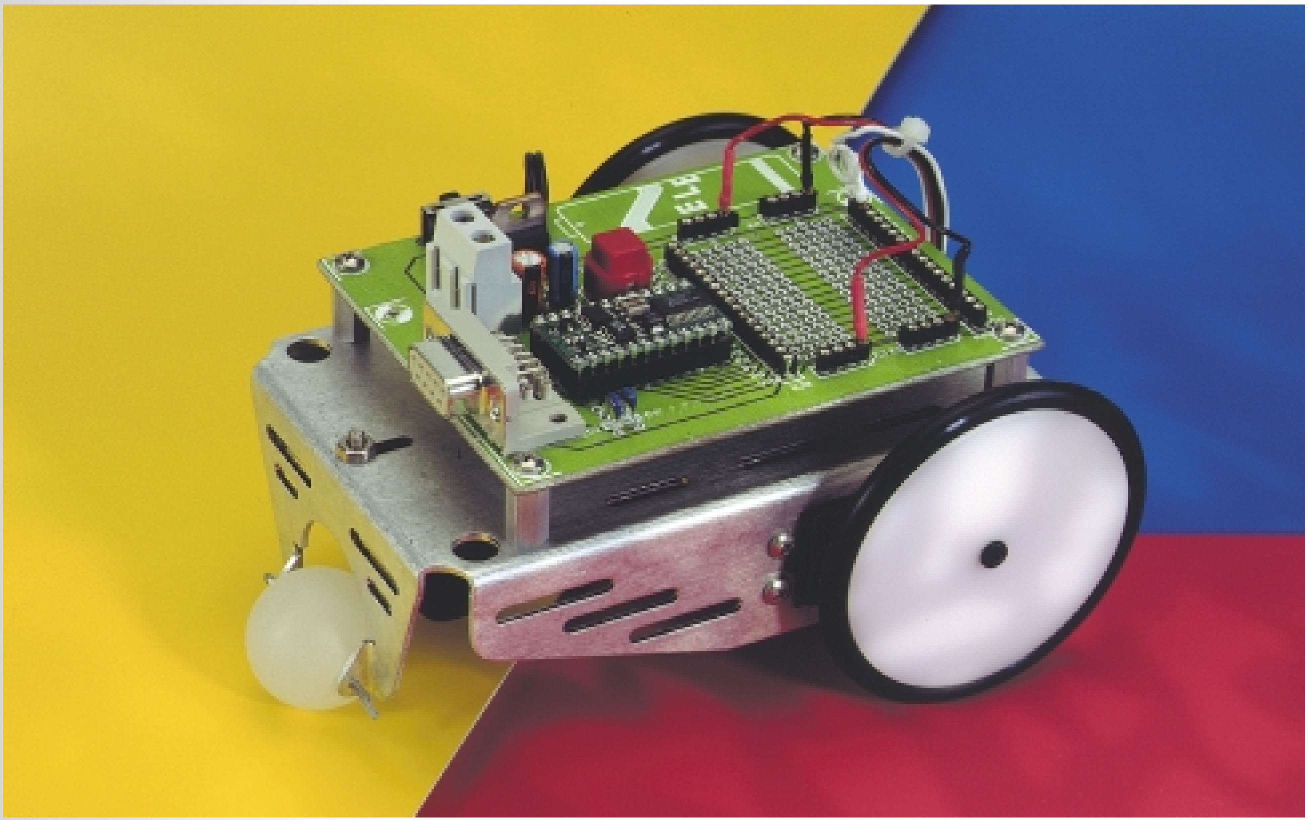
BASIC Stamp programming course (2)

Part 2: building the BOE-Bot


Robot vehicle with Elektor Electronics version of BOE installed on top.

By Chuck Schoeffler, Ph. D. and Ken Gracey

ASSEMBLING A ROBOT CHASSIS

The robot chassis needs to accommodate two servos for drivetrain, a battery pack, and have a prototype development area (the Board of Education). We're using a custom aluminum chassis that you can purchase (from Parallax Stamp dealers, *Ed.*), but we're providing dimensioned drawings so you can build your own from aluminum or plastic. In fact, you can download dimensioned Autocad *.dwg and *.dxf drawings for your own customization. These drawings may be edited to your specific needs and are available from *http://www.stampsinclass.com*

Figures 4 and 5 show the top and side dimensions of the BOE-Bot chassis.

ASSEMBLY OF THE BOE-BOT

Construction of the BOE-BOT platform consists of five parts:

1. Modifying the Futaba servos for full rotation.
2. Calibrating the servo.
3. Mounting the servos on the robotics platform and attaching the wheels.
4. Attaching the tail wheel and battery holder.
5. Mounting the BOE and connecting the servos to the controller.

Modifying the Futaba servo for continuous rotation

The BOE-Bot uses two modified Futaba S-148 servos. The S-148 provides low cost, easy-to-modify gear motors that let the platform move around. The servos are easily modified to let them rotate 360 degrees. When you purchase most hobby servos they are usually set up to move about 90 total. The servos respond to a pulse width modulation signal (PWM) that you send to it using the BASIC Stamp. This is accomplished using the PULSOUT command.

Modifying the Futaba S-148 servos takes only a few minutes (or less if you've done them before), is painless, only requires a Phillips screwdriver, a file or sandpaper, and a little careful disassembly. This modification can be reversed at a later date to make the servo operate like it was intended if you save the small plastic drive plate (we're going to remove it) or purchase the replacement gear set at a hobby shop.

The Futaba servos have a round control horn attached to the main output shaft and secured in place with a Phillips screw.

Turn the servo horn with your fingers until it stops. Turn it clockwise and counter-clockwise till the shaft stops to see how the servo will operate. We need to change it so that the control horn will rotate all the way around and not stop. When you're done playing, take the screw out and wiggle the control horn off the main output gear shaft. The gear shaft has splines on it, so you will have to apply upward pressure and then wiggle it off. Look at the bottom of the Futaba servo and find the four Phillips head screws on the bottom of the case because you will need to remove those in addition to the one Phillips screw that was holding the control horn on the main output gear.

Carefully remove the four Phillips screws from the bottom of the servo. The bottom plate of the servo will come off at this point so look at the control circuitry. You won't need to do any soldering unless you break a wire off or something else.

Hold your finger on the output gear shaft and press down (the one that the control horn was on) and carefully pry and wiggle the top of the servo case up and remove it. Work slowly so the gears all stay in place on their shafts. **Figure 6** shows a drawing of the servo case and gear names.

The final gear is the one you are going to modify. It's also the one you held down with your finger. You'll need to remove the 3rd gear in order to access the final gear. Looking at the top of the final gear you'll see a plastic stop tab that we need to file off to make the servo turn completely around when we issue commands. File, sand or cut the stop tab on the main output gear until it is gone (don't sand into the gear teeth). The tab is shown in **Figure 7**.

Turn the final gear over and look at the bottom. You will see a metal ring pressed into the plastic, and you need to pry that out with a small screwdriver, your fingernail or a paper clip. Remove the potentiometer drive plate. You might want to save this plastic part if you ever want to convert the servo back to its normal mode of operation. Insert the metal ring back into the main gear. **Figure 8** shows the bottom of the main gear.

Calibrating the servos

Before assembling the servo back together you should check the calibration of the servo and make it stop moving when the BASIC Stamp sends a PULSOUT command of 750. At this point get out your BASIC Stamp or BOE and enter the appropriate program listed in **Listing 1**. You will need to connect your BASIC Stamp to an IBM PC, enter the source code in the editor and download. The BASIC Stamp software editor is available for free download from

4

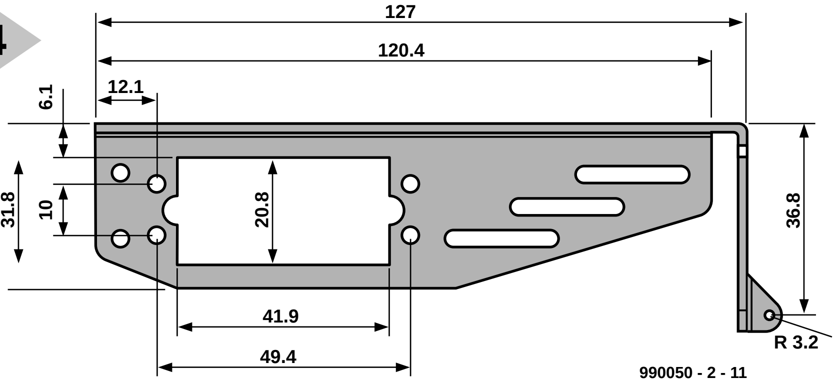
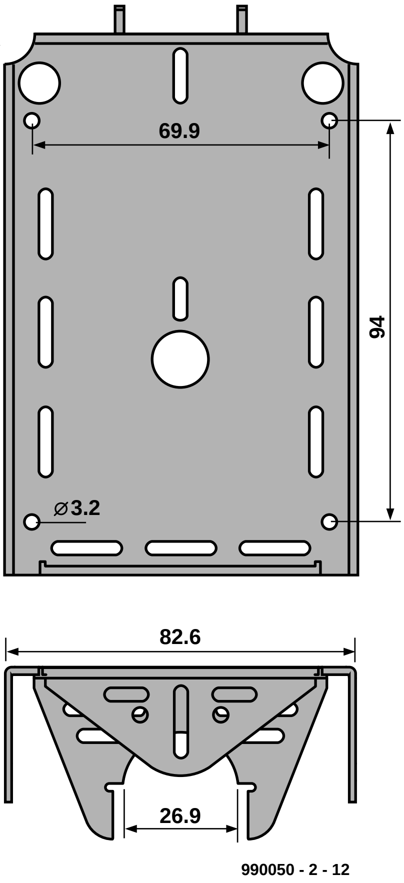


Figure 4. Chassis dimensioned (mm), viewpoint from side (no scale).

Figure 5. Chassis dimensioned (mm), viewpoint from top and rear (no scale).

5



6

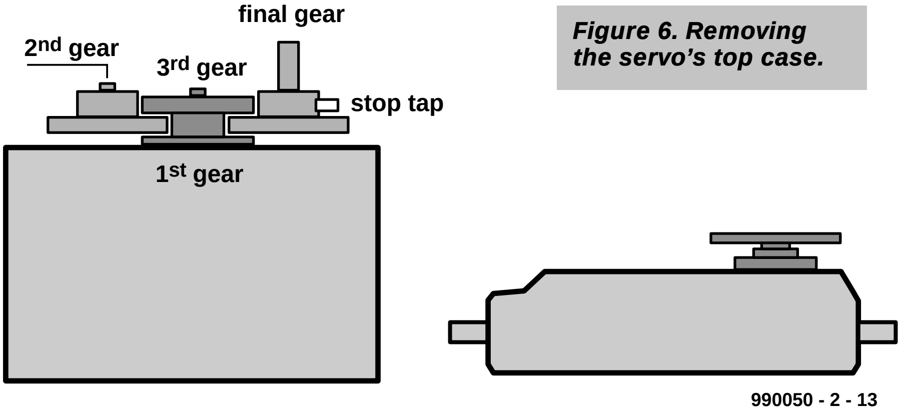


Figure 6. Removing the servo's top case.

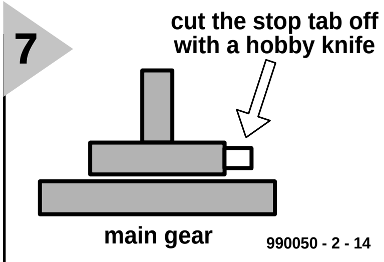


Figure 7. Removing the final gear stop tab.

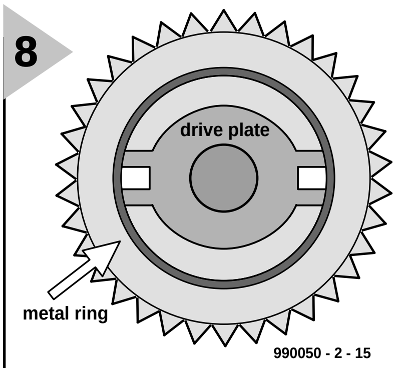


Figure 8. Main gear seen from bottom — remove the drive plate.

http://www.parallaxinc.com

The servo calibration schematic is shown in **Figure 9**.

If you are not using the BOE for the servo calibration you *must* use a separate 5 or 6 VDC source of power to operate the servos. If you do not you're liable to burn out the regulator on the BASIC Stamp. The BOE uses a low-dropout regulator and it can drive the servos from its output. When using a 6-volt power supply connect the servo power and ground directly to the battery terminals. If you connect the servos directly to voltages higher than 5 or 6 VDC you may notice that they don't operate correctly under program control and you might damage them. If you damage the servos, it's usually just the servo control board that has something wrong with it and you can remove that and still use the servo as a high torque gear motor. They are still useable for robotics but you won't be able to use the PULSOUT command to make them turn clockwise and counter-clockwise anymore.

Load your calibration program into the BASIC Stamp and see if the servo gears are turning. If they are then you will need to adjust the potentiometer (pot) shaft underneath the main gear until everything stops moving. Once you have stopped all motion then you can unplug the servo and put it back together.

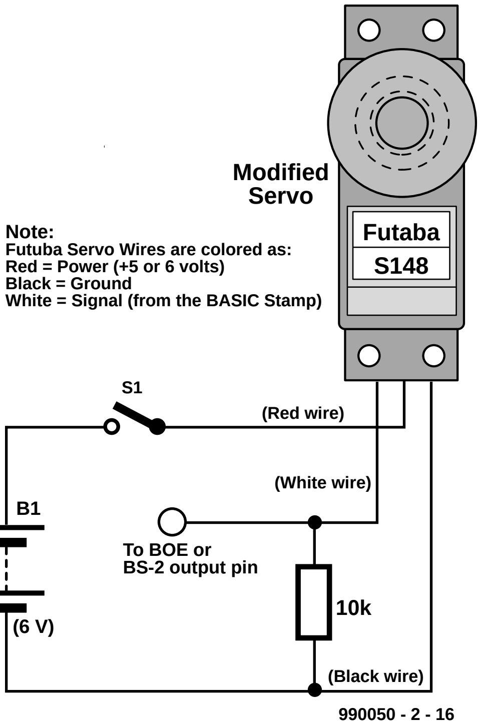


Figure 9. Servo calibration schematic.

Listing 1. Servo calibration code

```
'Program for calibrating servo to its center using BS-2
'C. Schoeffler, University of Idaho

center:         'establishes a name for this calibration routine
pulsout 15, 750 'sends a pulse of 1.5 milliseconds to the servo
pause 20        'delay between pulses is 10 ms to 20 ms
goto center
```

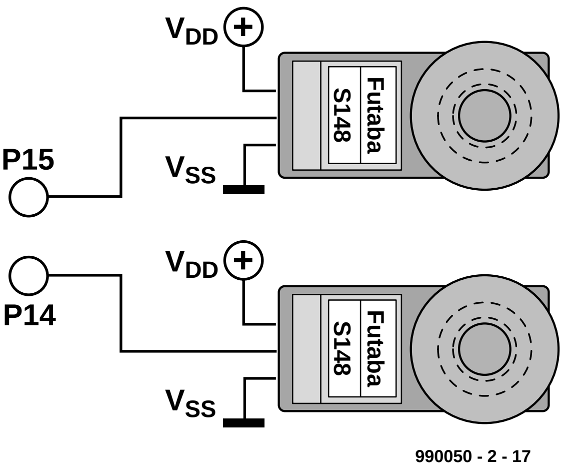
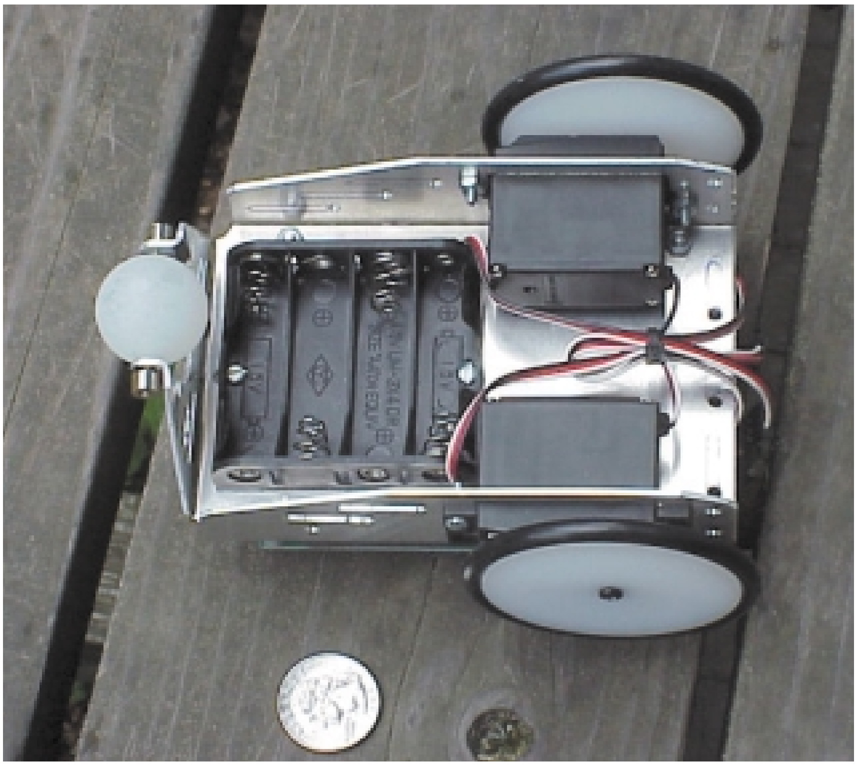


Figure 10. BOE-Bot drivetrain schematic.

Check the servo again before putting all the screws back in to see if the servo is indeed stopped when you sent it the test program. The servo case parts should go back together smoothly and when put together you should just barely be able to see where the case part joins together.

Figure 11. BOE-Bot undercarriage.



Mounting the servos on the robotics platform

When you're done modifying and testing the servos you can install them on your robot chassis and connect them to the BASIC Stamp. **Figure 10** shows the completed servo schematic interfacing to the BASIC Stamp. Futaba wires are easy to identify. Red is positive 5 or 6 VDC, black is the negative wire, and the white wire is the signal wire. The BOE-Bot is configured to just plug and unplug the battery power supply so you don't need a switch. After you have installed the servos in the BOE-BOT base, attach the wheels and secure them with a Phillips screw that is normally used to secure the control horn on the servo.

Attaching the tail wheel and battery holder

If you are using the chassis design we featured, mount the tail wheel using a steel wire or cotter pin. We used a 25.4 mm polyethylene ball for the tail wheel. Drill a hole through the tail wheel. **Figure 10** shows how the battery holder is mounted under the BOE-Bot base. Mount the battery holder and solder some wires to the terminals so you can bring the 6 VDC up to the top of the BOE-BOT. If you aren't using this metal chassis then consider double-sided tape or Velcro.

Mounting the Board of Education

Mount the BOE on the robot chassis using machine screws and standoffs. Using aluminum 1/2-inch (12 mm) standoffs with machine screws works well. Again, you could even use double-sided tape, but be sure that the BOE doesn't short-circuit with the robot chassis.

CONCLUSION

Now that you've got a robotic platform based on the BASIC Stamp, it's time to prepare for learning simple I/O control.

Next month we'll start with BASIC programming and proceed to implement a sensor.

(990050-2)

Internet

http://www.parallaxinc.com – BASIC Stamp Manual Version 1.9, BASIC Stamp DOS and Windows Editor, program examples. International distribution sources.

*http://www.stampsinclass.com —BoE documentation, Robotics curriculum, BoE-Bot *.dxf and *.dwg drawing formats, discussion group for educational uses of BASIC Stamp.*

chucks@turbonet.com — creator of the BoE-Bot and author of this series. Technical assistance.

kgracey@parallaxinc.com — co-author of this article. Technical assistance and questions about the educational program.

http://www.milinst.demon.co.uk — UK distributor of Parallax BASIC Stamp.

Figure 12. Contents of the robot kit supplied by Parallax Stamp dealers. The metal chassis is to be made available as a separate item.